

# **El Niño and La Niña Episodes and Their Impact On The Weather In Death Valley**

## **Introduction**

El Niño and La Niña episodes have been shown in numerous studies to have large scale and regional impacts on weather patterns and seasonal climate averages. This study presents the observed values of temperature and precipitation values to see what, if any, correlations there are due to El Niño and La Niña episodes on a more local scale.

## **Methodology**

Oceanic Niño Index (ONI) values, defined as sea surface temperature anomalies in the Niño 3.4 region (located at 5°N to 5°S and 120° to 170°W) of the eastern and central equatorial Pacific Ocean based on centered 30-year base periods updated every 5 years, were obtained from the Climate Prediction Center (CPC) for each year since 1950 to the present. These values were analyzed for departures of 0.5°C warmer than normal for at least five consecutive overlapping three month seasons which indicated an El Niño episode and departures of 0.5°C cooler than normal for at least five consecutive overlapping three month seasons which inferred a La Niña episode for the purposes of this report. It should be noted that this criteria is also what CPC uses to define El Niño and La Niña episodes. Episodes were then defined from a July-June period for simplistic purposes for the compilation of this report.

The next step was to rate El Niño and La Niña episodes into three categories – strong, moderate and weak based on ONI values. At least three consecutive three month periods with a given value were used to rate episodes. The thresholds for rating ONI values were obtained from correspondence with CPC in a previous study on El Niño and La Niña episodes done by the author.

For El Niño episodes events were defined as:

Weak – ONI values from +0.5°C to +0.9°C

Moderate – ONI values from +1.0°C to +1.8°C

High – ONI values greater than +1.8°C

For La Niña episodes events were defined as:

Weak – ONI values from -0.5°C to -0.9°C

Moderate – ONI values from -1.0°C to -1.8°C

High – ONI values greater than -1.8°C

## **Precipitation and Snowfall**

The table below lists precipitation totals for the July through June period for years with an El Niño episode as well as for the November through April time frame in order to look at precipitation totals not influenced by the monsoon. In order to compute normals, totals for the 1981-2010 period were ranked from greatest to least and then split into thirds. Those values were then used to denote above normal (upper third), near normal (middle third) and below normal (bottom third). The cut-offs for these thresholds were then used as the thirty year normal for defining above normal, near normal and below normal precipitation. These cut-offs were then applied to any season that met El Niño criteria and the totals for a given season were then rated above normal (shown in green for precipitation and blue for snow), near normal (shown in black) and below normal (shown in brown for precipitation and purple for snow).

| <b>Episode</b>                                | <b>Strength of Episode</b> | <b>Death Valley July-June Precipitation Total</b> | <b>Death Valley July-June Seasonal Snowfall Total</b> | <b>Death Valley November-April Precipitation Total</b> |
|---|----------------------------|---|---|--|
| <b>1951-1952</b>                              | Moderate                   | 2.57"   | 0.0"  | 2.51"  |
| <b>1952-1953</b>                              | Weak                       | 1.07"   | 0.0"  | 0.94"  |
| <b>1953-1954</b>                              | Weak                       | 1.42"   | 0.0"  | 1.42"  |
| <b>1957-1958</b>                              | Moderate                   | M   | M   | M  |
| <b>1963-1964</b>                              | Moderate                   | 1.51"   | 0.0"  | 0.37"  |
| <b>1965-1966</b>                              | Moderate                   | 2.03"   | 0.0"  | 1.55"  |
| <b>1968-1969</b>                              | Moderate                   | 2.66"   | 0.0"  | 2.42"  |
| <b>1969-1970</b>                              | Moderate                   | 2.23"   | 0.0"  | 1.73"  |
| <b>1972-1973</b>                              | Strong                     | 3.64"   | 0.0"  | 2.49"  |
| <b>1976-1977</b>                              | Weak                       | 2.74"   | 0.0"  | 0.24"  |
| <b>1977-1978</b>                              | Weak                       | 5.09"   | 0.0"  | 3.61"  |
| <b>1982-1983</b>                              | Strong                     | 3.37"   | 0.0"  | 2.85"  |
| <b>1986-1987</b>                              | Moderate                   | 1.96"   | 0.0"  | 1.66"  |
| <b>1987-1988</b>                              | Moderate                   | 5.78"   | 0.0"  | 5.41"  |
| <b>1991-1992</b>                              | Moderate                   | 2.78"   | 0.0"  | 2.56"  |
| <b>1994-1995</b>                              | Moderate                   | 3.42"*  | 0.0"  | 3.07"*   |
| <b>1997-1998</b>                              | Strong                     | 6.09"   | 0.0"  | 3.94"  |
| <b>2002-2003</b>                              | Moderate                   | 2.13"   | 0.0"  | 2.01"  |
| <b>2004-2005</b>                              | Weak                       | 6.44"   | 0.0"  | 5.44"  |
| <b>2006-2007</b>                              | Weak                       | 1.20"   | 0.0"  | 0.37"  |
| <b>2009-2010</b>                              | Moderate                   | 3.31"   | 0.0"  | 3.27"  |
| <b>30 Year Normal</b>                         | N/A                        | 2.36"   | 0.0"  | 1.80"  |
| <b>Average for Moderate and Strong Events</b> | N/A                        | 3.11"   | 0.0"  | 2.56"  |

\* Missing data for December 1994.

Overall there appears to be a good correlation between El Niño episodes and near to above normal precipitation during both the water season and the cold season in Death Valley especially during strong events. The five wettest 24 hour precipitation totals in Death Valley ever recorded since 1949 were all during El Niño episodes, with four of these five occurring in the cold season and the other occurring from Tropical Storm Nora. Since 1911, there have only been 45 months in Death Valley that have recorded an inch or more of precipitation during the cold season from November through April. Since 1949, there are only 30 months that have reached this mark, with 20 months or 67 percent of them occurring during El Niño episodes. No snow has ever been recorded in Death Valley during an El Niño episode.

The table below lists precipitation totals for the July through June period for years with a La Niña episode as well as for the November through April time frame in order to look at precipitation totals not influenced by the monsoon. In order to compute normals, totals for the 1981-2010 period were ranked from greatest to least and then split into thirds. Those values were then used to denote above normal (upper third), near normal (middle third) and below normal (bottom third). The cut-offs for these thresholds were then used as the thirty year normal for defining above normal, near normal and below normal precipitation. These cut-offs were then applied to any season that met La Niña criteria and the totals for a given season were then rated above normal (shown in green for precipitation and blue for snow), near normal (shown in black) and below normal (shown in brown for precipitation and purple for snow).

| Episode                                | Strength of Episode | Death Valley July-June Precipitation Total | Death Valley July-June Seasonal Snowfall Total | Death Valley November-April Precipitation Total |
|--|---------------------|--|--|---|
| 1949-1950                              | Moderate            | 0.19"                                      | 0.0"   | 0.05"   |
| 1950-1951                              | Weak                | 1.27"                                      | 0.0"   | 0.05"   |
| 1954-1955                              | Weak                | 1.97"                                      | 0.0"   | 1.14"   |
| 1955-1956                              | Moderate            | 0.41"                                      | 0.0"   | 0.41"   |
| 1956-1957                              | Weak                | 1.77"                                      | 0.0"   | 0.82"   |
| 1964-1965                              | Weak                | 2.36"                                      | 0.0"   | 1.52"   |
| 1970-1971                              | Moderate            | 1.19"                                      | 0.0"   | 1.04"   |
| 1971-1972                              | Weak                | 1.32"                                      | 0.0"   | 0.72"   |
| 1973-1974                              | Strong              | 1.90"                                      | Trace  | 1.72"   |
| 1974-1975                              | Weak                | 2.61"                                      | 0.0"   | 1.11"   |
| 1975-1976                              | Moderate            | 3.44"                                      | 0.0"   | 2.57"   |
| 1983-1984                              | Weak                | 1.88"                                      | 0.0"   | 0.55"   |
| 1984-1985                              | Moderate            | 1.95"*                                     | 0.0"   | M   |
| 1988-1989                              | Strong              | 0.68"                                      | 0.0"   | 0.05"   |
| 1995-1996                              | Weak                | 0.71"                                      | 0.0"   | 0.55"   |
| 1998-1999                              | Moderate            | 1.24"                                      | 0.0"   | 0.60"   |
| 1999-2000                              | Moderate            | 1.23"                                      | 0.0"   | 0.72"   |
| 2000-2001                              | Weak                | 2.70"                                      | 0.0"   | 2.43"   |
| 2005-2006                              | Weak                | 1.97"                                      | 0.0"   | 0.59"   |
| 2007-2008                              | Moderate            | 1.58"                                      | 0.0"   | 0.93"   |
| 2010-2011                              | Moderate            | 1.19"                                      | 0.0"   | 0.81"   |
| 2011-2012                              | Weak                | 2.15"                                      | 0.0"   | 0.30"   |
| 30 Year Normal                         | N/A                 | 2.36"                                      | 0.0"   | 1.80"   |
| Average for Moderate and Strong Events | N/A                 | 1.36"                                      | 0.0"   | 0.89"   |

\* Missing data for December 1984.

Overall there is a good correlation between La Niña episodes and near to below normal precipitation during both the water season and especially during the cold season at Death Valley. Moderate to strong events tended to have the best correlation to below normal precipitation. There were several interesting trends to note though. The La Niña episode of 1955-1956 had precipitation in just two months – November and April with the only measurable precipitation falling during April. The strong 1988-1989 La Niña episode had measurable precipitation in August, September, November and December and a trace in January but nothing in any month from February through June. The 1973-1974 La Niña, while strong, did result in near normal precipitation for the cold season. This was also the only La Niña episode where snow fell at Death Valley and one only of 4 winter seasons where snow has ever fallen here. Traces of snow fell on two days that month – the 4<sup>th</sup> and 5<sup>th</sup>. There has been a noted trend in the Southwest U.S. to see snow in La Niña winters in lower elevations.

## Temperature

The table below lists the average temperature for meteorological winter (December through February) for years with an El Niño episode. In order to compute normals, average temperatures for the 1981-2010 period were ranked from greatest to least and then split into thirds. Those values were then used to denote above normal (upper third), near normal (middle third) and below normal (bottom third). The cut-offs for these thresholds were then used as the thirty year normal for defining above normal, near normal and below normal temperatures. These cut-offs were then applied to any season that met El Niño criteria and the totals for a given season were then rated above normal (shown in orange), near normal (shown in black) and below normal (shown in blue).

| <b>Episode</b>                                | <b>Strength of Episode</b> | <b>Death Valley Average Temperature</b> |
|---|----------------------------|---|
| <b>1951-1952</b>                              | Moderate                   | 53.6                                    |
| <b>1952-1953</b>                              | Weak                       | 55.6                                    |
| <b>1953-1954</b>                              | Weak                       | 56.0                                    |
| <b>1957-1958</b>                              | Moderate                   | M                                       |
| <b>1963-1964</b>                              | Moderate                   | 53.3                                    |
| <b>1965-1966</b>                              | Moderate                   | 50.8                                    |
| <b>1968-1969</b>                              | Moderate                   | 52.8                                    |
| <b>1969-1970</b>                              | Moderate                   | 55.3                                    |
| <b>1972-1973</b>                              | Strong                     | 52.8                                    |
| <b>1976-1977</b>                              | Weak                       | 54.6                                    |
| <b>1977-1978</b>                              | Weak                       | 57.1                                    |
| <b>1982-1983</b>                              | Strong                     | 53.9                                    |
| <b>1986-1987</b>                              | Moderate                   | 55.0                                    |
| <b>1987-1988</b>                              | Moderate                   | 53.1                                    |
| <b>1991-1992</b>                              | Moderate                   | 54.5                                    |
| <b>1994-1995</b>                              | Moderate                   | 55.9                                    |
| <b>1997-1998</b>                              | Strong                     | 51.9                                    |
| <b>2002-2003</b>                              | Moderate                   | 56.9                                    |
| <b>2004-2005</b>                              | Weak                       | 56.9                                    |
| <b>2006-2007</b>                              | Weak                       | 54.8                                    |
| <b>2009-2010</b>                              | Moderate                   | 53.5                                    |
| <b>30 Year Normal</b>                         | N/A                        | 55.0                                    |
| <b>Average for Moderate and Strong Events</b> | N/A                        | 53.8                                    |

Overall temperatures in Death Valley during meteorological winter average near to below normal during El Niño episodes, especially during strong ones.

The table below lists the average temperature for meteorological winter (December through February) for years with a La Niña episode. In order to compute normals, average temperatures for the 1981-2010 period were ranked from greatest to least and then split into thirds. Those values were then used to denote above normal (upper third), near normal (middle third) and below normal (bottom third). The cut-offs for these thresholds were then used as the thirty year normal for defining above normal, near normal and below normal temperatures. These cut-offs were then applied to any season that met La Niña criteria and the totals for a given season were then rated above normal (shown in orange), near normal (shown in black) and below normal (shown in blue).

| <b>Episode</b>                                | <b>Strength of Episode</b> | <b>Death Valley Average Temperature</b> |
|---|----------------------------|---|
| <b>1949-1950</b>                              | Moderate                   | 52.4                                    |
| <b>1950-1951</b>                              | Weak                       | 55.4                                    |
| <b>1954-1955</b>                              | Weak                       | 51.4                                    |
| <b>1955-1956</b>                              | Moderate                   | 54.3                                    |
| <b>1956-1957</b>                              | Weak                       | 54.5                                    |
| <b>1964-1965</b>                              | Weak                       | 57.0                                    |
| <b>1970-1971</b>                              | Moderate                   | 54.9                                    |
| <b>1971-1972</b>                              | Weak                       | 53.4                                    |
| <b>1973-1974</b>                              | Strong                     | 54.3                                    |
| <b>1974-1975</b>                              | Weak                       | 54.4                                    |
| <b>1975-1976</b>                              | Moderate                   | 57.0                                    |
| <b>1983-1984</b>                              | Weak                       | 55.7                                    |
| <b>1984-1985</b>                              | Moderate                   | 52.1                                    |
| <b>1988-1989</b>                              | Strong                     | 53.6                                    |
| <b>1995-1996</b>                              | Weak                       | 57.1                                    |
| <b>1998-1999</b>                              | Moderate                   | 55.7                                    |
| <b>1999-2000</b>                              | Moderate                   | 56.5                                    |
| <b>2000-2001</b>                              | Weak                       | 52.1                                    |
| <b>2005-2006</b>                              | Weak                       | 56.2                                    |
| <b>2007-2008</b>                              | Moderate                   | 54.4                                    |
| <b>2010-2011</b>                              | Moderate                   | 54.5                                    |
| <b>2011-2012</b>                              | Weak                       | 56.0                                    |
| <b>30 Year Normal</b>                         | N/A                        | 55.0                                    |
| <b>Average for Moderate and Strong Events</b> | N/A                        | 54.5                                    |

Overall the only correlation between La Niña episodes and temperatures during meteorological winter in Death Valley was during strong events when they

averaged near normal. During weak to moderate events no correlation can be made.

### **Low Temperatures of 32 Degrees or Below**

The table below lists the number of days with minimum temperatures of 32°F or below (above average years shown in blue) with an El Niño episode (July-June period).

| <b>Episode</b>                                | <b>Strength of Episode</b> | <b>Number of Days With Minimum Temperatures of 32 °F or Below At Death Valley</b> |
|---|----------------------------|---|
| <b>1951-1952</b>                              | Moderate                   | 13  |
| <b>1952-1953</b>                              | Weak                       | 4   |
| <b>1953-1954</b>                              | Weak                       | 12  |
| <b>1957-1958</b>                              | Moderate                   | M   |
| <b>1963-1964</b>                              | Moderate                   | 15  |
| <b>1965-1966</b>                              | Moderate                   | 16  |
| <b>1968-1969</b>                              | Moderate                   | 18  |
| <b>1969-1970</b>                              | Moderate                   | 7   |
| <b>1972-1973</b>                              | Strong                     | 19  |
| <b>1976-1977</b>                              | Weak                       | 18  |
| <b>1977-1978</b>                              | Weak                       | 0   |
| <b>1982-1983</b>                              | Strong                     | 15  |
| <b>1986-1987</b>                              | Moderate                   | 1   |
| <b>1987-1988</b>                              | Moderate                   | 10  |
| <b>1991-1992</b>                              | Moderate                   | 6   |
| <b>1994-1995</b>                              | Moderate                   | 18  |
| <b>1997-1998</b>                              | Strong                     | 15  |
| <b>2002-2003</b>                              | Moderate                   | 1   |
| <b>2004-2005</b>                              | Weak                       | 3   |
| <b>2006-2007</b>                              | Weak                       | 11  |
| <b>2009-2010</b>                              | Moderate                   | 11  |
| <b>30 Year Normal</b>                         | N/A                        | 7.2   |
| <b>Average for Moderate and Strong Events</b> | N/A                        | 11.8  |

Overall there appears to be a good correlation for an above normal of days with a minimum temperature of 32 degrees or below during El Niños at Death Valley, especially during strong events.

The table below lists the number of days with minimum temperatures of 32°F or below (above average years shown in blue) with a La Niña episode (July-June period).

| <b>Episode</b>                                | <b>Strength of Episode</b> | <b>Number of Days With Minimum Temperatures of 32 °F or Below At Death Valley</b> |
|---|----------------------------|---|
| <b>1949-1950</b>                              | Moderate                   | 40  |
| <b>1950-1951</b>                              | Weak                       | 6   |
| <b>1954-1955</b>                              | Weak                       | 11  |
| <b>1955-1956</b>                              | Moderate                   | 9   |
| <b>1956-1957</b>                              | Weak                       | 12  |
| <b>1964-1965</b>                              | Weak                       | 11  |
| <b>1970-1971</b>                              | Moderate                   | 5   |
| <b>1971-1972</b>                              | Weak                       | 18  |
| <b>1973-1974</b>                              | Strong                     | 3   |
| <b>1974-1975</b>                              | Weak                       | 4   |
| <b>1975-1976</b>                              | Moderate                   | 6   |
| <b>1983-1984</b>                              | Weak                       | 2   |
| <b>1984-1985</b>                              | Moderate                   | 16  |
| <b>1988-1989</b>                              | Strong                     | 21  |
| <b>1995-1996</b>                              | Weak                       | 6   |
| <b>1998-1999</b>                              | Moderate                   | 12  |
| <b>1999-2000</b>                              | Moderate                   | 15  |
| <b>2000-2001</b>                              | Weak                       | 17  |
| <b>2005-2006</b>                              | Weak                       | 5   |
| <b>2007-2008</b>                              | Moderate                   | 6   |
| <b>2010-2011</b>                              | Moderate                   | 6   |
| <b>2011-2012</b>                              | Weak                       | 7   |
| <b>30 Year Normal</b>                         | N/A                        | 7.2   |
| <b>Average for Moderate and Strong Events</b> | N/A                        | 12.6  |

Overall no conclusion can be made about the number of low temperatures that reached 32 degrees or below in Death Valley during December when a La Niña occurs.